



SEQUENCE LISTING

<110> Saltveit, Michael E.
Campos, Reinaldo
Nonogaki, Hiroyuki
Suslow, Trevor
The Regents of the University of California

<120> Characterization of Phenylalanine Ammonia-Lyase (PAL)
Gene in Wounded Lettuce Tissue

<130> 023070-124500US

<140> US 09/964,992

<141> 2001-09-26

<150> US 60/235,956

<151> 2000-09-26

<160> 13

<170> PatentIn Ver. 2.1

<210> 1

<211> 711

<212> PRT

<213> Lactuca sativa

<220>

<223> lettuce phenylalanine ammonia-lyase (PAL) 1
(LsPAL1)

<400> 1

Met Glu Asn Gly Asn His Val Asn Gly Val Val Asn Glu Leu Cys Ile
1 5 10 15

Lys Asp Pro Leu Asn Trp Gly Val Ala Ala Glu Ala Leu Thr Gly Ser
20 25 30

His Leu Asp Glu Val Lys Lys Met Val Ala Glu Phe Arg Lys Pro Val
35 40 45

Val Lys Leu Gly Gly Glu Thr Leu Thr Val Ser Gln Val Ala Gly Ile
50 55 60

Ala Ala Ala Asn Asp Ser Asp Thr Val Lys Val Glu Leu Ser Glu Ala
65 70 75 80

Ala Arg Ala Gly Val Lys Ala Ser Ser Asp Trp Val Met Glu Ser Met
85 90 95

Asn Lys Gly Thr Asp Ser Tyr Gly Val Thr Thr Gly Phe Gly Ala Thr
100 105 110

Ser His Arg Arg Thr Lys Gln Gly Ala Leu Gln Lys Glu Leu Ile
115 120 125

Arg Phe Leu Asn Ala Gly Ile Phe Gly Asn Gly Thr Glu Thr Ser His
130 135 140

Thr Leu Pro His Ser Ala Thr Arg Ala Ala Met Ile Val Arg Ile Asn
145 150 155 160

Thr Leu Leu Gln Gly Tyr Ser Gly Ile Arg Phe Glu Ile Leu Glu Ala
165 170 175

Ile Thr Lys Phe Leu Asn Asn Asn Ile Thr Pro Cys Leu Pro Leu Arg
180 185 190

Gly Thr Ile Thr Ala Ser Gly Asp Leu Val Pro Leu Ser Tyr Ile Ala
195 200 205

Gly Leu Leu Thr Gly Arg Pro Asn Ser Lys Ala Val Gly Pro Thr Gly
210 215 220

Glu Val Leu Asn Ala Glu Lys Ala Phe Ala Ala Gly Val Glu Gly
225 230 235 240

Gly Phe Glu Leu Gln Pro Lys Glu Gly Leu Ala Leu Val Asn Gly
245 250 255

Thr Ala Val Gly Ser Gly Met Ala Ser Met Val Leu Phe Asp Ala Asn
260 265 270

Val Leu Ala Leu Leu Ser Glu Val Leu Ser Ala Ile Phe Ala Glu Val
275 280 285

Met Gln Gly Lys Pro Glu Phe Thr Asp His Leu Thr His Lys Leu Lys
290 295 300

His His Pro Gly Gln Ile Glu Ala Ala Ile Met Glu Tyr Ile Leu
305 310 315 320

Asp Gly Ser Asp Tyr Val Lys Ala Ala Gln Lys Val His Glu Met Asp
325 330 335

Pro Leu Gln Lys Pro Lys Gln Asp Arg Tyr Ala Leu Arg Thr Ser Pro
340 345 350

Gln Trp Leu Gly Pro Gln Ile Glu Val Ile Arg Ser Ser Thr Lys Met
355 360 365

Ile Glu Arg Glu Ile Asn Ser Val Asn Asp Asn Pro Leu Ile Asp Val
370 375 380

Ser Arg Asn Lys Ala Leu His Gly Gly Asn Phe Gln Gly Thr Pro Ile
385 390 395 400

Gly Val Ser Met Asp Asn Thr Arg Leu Ala Ile Ala Ala Ile Gly Lys
405 410 415

Leu Met Phe Ala Gln Phe Ser Glu Leu Val Asn Asp Phe Tyr Asn Asn
420 425 430

Gly Leu Pro Ser Asn Leu Ser Gly Gly Arg Asn Pro Ser Leu Asp Tyr
435 440 445

Gly Phe Lys Gly Gly Glu Ile Ala Met Ala Ser Tyr Cys Ser Glu Leu
450 455 460

Gln Phe Leu Ala Asn Pro Val Thr Asn His Val Gln Ser Ala Glu Gln
465 470 475 480

His Asn Gln Asp Val Asn Ser Leu Gly Leu Ile Ser Ala Arg Lys Thr
485 490 495

Ala Glu Ala Val Asp Ile Leu Lys Leu Met Ser Ser Thr Tyr Leu Val
500 505 510

Ala Leu Cys Gln Ser Ile Asp Leu Arg His Leu Glu Glu Asn Met Lys
515 520 525

Ser Thr Val Lys Asn Thr Val Ser Gln Val Ala Lys Lys Val Leu Thr
530 535 540

Met Gly Val Asn Gly Glu Leu His Pro Ser Arg Phe Cys Glu Lys Asp
545 550 555 560

Leu Leu Arg Val Val Asp Arg Glu Tyr Val Phe Ala Tyr Ile Asp Asp
565 570 575

Val Cys Ser Gly Thr Tyr Pro Leu Met Gln Lys Leu Arg Gln Val Leu
580 585 590

Val Asp His Ala Leu Asn Asn Gly Glu Thr Glu Lys Asn Thr Asn Thr
595 600 605

Ser Ile Phe Gln Lys Ile Ala Thr Phe Glu Glu Leu Lys Val Leu
610 615 620

Leu Pro Lys Glu Val Glu Gly Val Arg Ile Ala Tyr Glu Asn Asp Thr
625 630 635 640

Leu Ser Ile Pro Asn Arg Ile Lys Ala Cys Arg Ser Tyr Pro Leu Tyr
645 650 655

Arg Phe Val Arg Glu Glu Leu Gly Arg Gly Phe Leu Thr Gly Glu Lys
660 665 670

Val Thr Ser Pro Gly Glu Glu Phe Asp Arg Val Phe Thr Ala Met Cys
675 680 685

Lys Gly Gln Ile Ile Asp Pro Leu Leu Glu Cys Leu Gly Gly Trp Asn
690 695 700

Gly Glu Pro Leu Pro Ile Cys
705 710

<210> 2
<211> 713
<212> PRT
<213> Lactuca sativa

<220>
<223> lettuce phenylalanine ammonia-lyase (PAL) 2
(LsPAL2)

<400> 2
Met Gly Ser Thr Glu Met Glu Val Asp Ser His Gln Asn Gly Glu Arg
1 5 10 15

Ala Glu Phe Cys Val Lys Gly Asp Pro Leu Asn Trp Gly Met Ala Ala
20 25 30

Glu Ser Leu Lys Gly Ser His Leu Asp Glu Val Lys Arg Met Val Ala
35 40 45

Glu Phe Arg Lys Pro Val Val Arg Leu Gly Gly Glu Thr Leu Thr Val
50 55 60

Ser Gln Val Ala Ala Ile Ala Ala Ser Asp Asn Ala Gly Val Lys Val
65 70 75 80

Glu Leu Ser Glu Thr Ala Arg Ala Gly Val Lys Ala Ser Ser Asp Trp
85 90 95

Val Met Glu Ser Met Asn Lys Gly Thr Asp Ser Tyr Gly Val Thr Thr
100 105 110

Gly Phe Gly Ala Thr Ser His Arg Arg Thr Lys Glu Gly Gly Ala Leu
115 120 125

Gln Lys Glu Leu Ile Arg Phe Leu Asn Ala Gly Ile Phe Gly Asn Gly
130 135 140

Thr Glu Ser Thr His Thr Leu Pro His Ser Ala Thr Arg Ala Ala Met
145 150 155 160

Leu Val Arg Ile Asn Thr Leu Leu Gln Gly Tyr Ser Gly Ile Arg Phe
165 170 175

Glu Ile Leu Glu Ala Ile Thr Lys Phe Leu Asn His Asn Val Thr Pro
180 185 190

Phe Leu Pro Leu Arg Gly Thr Ile Thr Ala Ser Gly Asp Leu Val Pro
195 200 205

Leu Ser Tyr Ile Ala Gly Leu Leu Thr Gly Arg Ala Asn Ser Lys Ala
210 215 220

Val Gly Pro Thr Gly Glu Val Leu Asn Ala Glu Lys Ala Phe Ala Glu
225 230 235 240

Ala Gly Val Glu Gly Gly Phe Phe Glu Leu Gln Pro Lys Glu Gly Leu
245 250 255

Ala Leu Val Asn Gly Thr Ala Val Gly Ser Gly Met Ala Ser Met Val
260 265 270

Leu Phe Asp Ala Asn Val Leu Ala Leu Leu Ser Glu Val Leu Ser Ala
275 280 285

Ile Phe Ala Glu Val Met Gln Gly Lys Pro Glu Phe Thr Asp His Leu
290 295 300

Thr His Lys Leu Lys His His Pro Gly Gln Ile Glu Ala Ala Ala Ile
305 310 315 320

Met Glu Tyr Ile Leu Asp Gly Ser Asp Tyr Val Lys Ala Ala Gln Lys
325 330 335

Val His Glu Met Asp Pro Leu Gln Lys Pro Lys Gln Asp Arg Tyr Ala
340 345 350

Leu Arg Thr Ser Pro Gln Trp Leu Gly Pro Gln Ile Glu Val Ile Arg
355 360 365

Ser Ser Thr Lys Met Ile Glu Arg Glu Ile Asn Ser Val Asn Asp Asn
370 375 380

Pro Leu Ile Asp Val Ser Arg Asn Lys Ala Leu His Gly Gly Asn Phe
385 390 395 400

Gln Gly Thr Pro Ile Gly Val Ser Met Asp Asn Thr Arg Leu Ala Ile
405 410 415

Ala Ala Ile Gly Lys Leu Met Phe Ala Gln Phe Ser Glu Leu Val Asn
420 425 430

Asp Phe Tyr Asn Asn Gly Leu Pro Ser Asn Leu Ser Gly Gly Arg Asn
435 440 445

Pro Ser Leu Asp Tyr Gly Phe Lys Gly Ala Glu Ile Ala Met Ala Ser
450 455 460

Tyr Cys Ser Glu Leu Gln Phe Leu Ala Asn Pro Val Thr Asn His Val
465 470 475 480

Gln Ser Ala Glu Gln His Asn Gln Asp Val Asn Ser Leu Gly Leu Ile
485 490 495

Ser Ala Arg Lys Thr Ala Glu Ser Val Glu Ile Leu Lys Leu Met Ser
500 505 510

Thr Thr Tyr Leu Val Ala Leu Cys Gln Ser Ile Asp Leu Arg His Leu
515 520 525

Glu Glu Asn Leu Lys Ser Thr Val Lys Asn Thr Val Ser Leu Val Ala
530 535 540

Lys Lys Ile Leu Thr Thr Gly Val Asn Gly Glu Leu His Pro Ser Arg
545 550 555 560

Phe Cys Glu Lys Asp Leu Leu Arg Val Val Asp Arg Glu Tyr Val Phe
565 570 575

Ala Tyr Ile Asp Asp Ala Cys Ser Ala Thr Tyr Pro Leu Met Gln Lys
580 585 590

Leu Arg Gln Val Ile Val Asp His Ala Leu Asn Asn Glu Asn Asp Ala
595 600 605

Gly Thr Ser Ile Phe Gln Lys Ile Ser Glu Phe Glu Glu Leu Lys
610 615 620

Ala Val Leu Pro Lys Glu Val Glu Gly Val Arg Ser Ala Tyr Glu Ser
625 630 635 640

Ser Thr Leu Thr Ile Pro Asn Arg Ile Lys Glu Cys Arg Ser Tyr Pro
645 650 655

Leu Tyr Arg Phe Val Arg Glu Glu Leu Gly Thr Gly Phe Leu Thr Gly
 660 665 670

Glu Glu Val Thr Ser Pro Gly Glu Glu Phe Asp Lys Val Phe Thr Ala
 675 680 685

Leu Cys Lys Gly His Ile Ile Asp Pro Leu Leu Glu Cys Val Gln Gly
690 695 700

705 710

<210> 3
<211> 2442
<212> DNA
<213> *Lactuca sativa*

<12>
<123> lettuce phenylalanine ammonia lyase (PAL) 1
(LsPAL1) cDNA

```
<120>
<221> CDS
<222> (119) .. (2254)
<223> PALL
```

<400> 3
 gagcaatctg atcaataccc attcacgcac aaagagtgtg agtctagtgt gtgaagaagt 60
 acacaattag attgttcttg ttctttgtat ctatagtcata caatctgtat aaataataat 120
 ggagaacgggt aatcaegtta atggagtcgt taatgagttg tgcataagg atccattgaa 180
 ctggggagtt gcagcggagg ctgttgcacgg aagtccaccc gatgaggtga agaagatgtt 240
 tggggagttc agaaaagccgg tgggtgaagct cggaggagag acgttacag tttctcaggt 300
 gggggggatc gcagctgtca atgacagtga caccgtgaag gtggagctgt cggaaagccgc 360
 gagggtctgga gttaaaggcga gtagtatttgc gtttatggag agcatgaata aaggaaactga 420
 tagttatggc gtcacccaccc gtttggcgcg cacttcaccc cggagaacta agcaaggcggg 480
 tgccttacag aaggagctca tttagatccc gaaacggcggg atatttcggaa atggaaacggya 540
 aacaagccac acacttccac attcagccac cagacccggc atgatctca gaatcaacac 600
 cctcttccag gtttactccg gcatacgatt cggatcttgc gaagccatca ccaagttcct 660
 taatcaacaac atcaccctt gtttacccct cgggtggaaacc atcaccgcct cgggtgasct 720
 tgccttccatta tcatacatcg cggccttcc ttttccggcc cccaaactccaa aaggcgttgg 780
 cccacccggg gaagttccca atggccaaaa ggccttgcgt gcaacggggag ttgaagggtgg 840
 gtttttccgg ttaatggcga aagaagggtt agcaattttttt aacggcaccgg cctgtggggcc 900
 cgggatggct tccatggttc tattttgtgc taatgtactt ggttgcgttgcgg 960
 atcggcgttc ttctgtgggg ttatgtcaagg gaaacggggag ttacccggatc attttggaa 1020
 caaatgtcaag catcaaccctg gtcacccatca gggggggggcc atcatggagt atattttggaa 1080
 cggaaaggcat taatgtcaagg cggggccaaa ggtttccatca atggazzzgt tacagaaacc 1140
 aaaacaagat ctttatgttc tccgtacatc tcccaatgg ctcggasctc aaatcgaagt 1200
 aatccgatca tcaaccaaaa tgcattggagag gaaatcaat tccgtcaacg cccaaatggg 1260
 gatcjacgtt tccatggaaaaca aatgttaca cgggtggtaat tccaaaggaa tgcgttgcgtca 1320
 agtttccatg gacaacaccc gtcctccat tgcgtcaatc gggaaaactca attttctgag 1380
 ctgggttaacg atttttacaa caatggatta ccatcgaatc tccatgggtgg 1440
 acgttaaccct agtttggact acgggttcaa aggtggagaa atcggccatgg ttcttactg 1500
 ttctgtggctt cagtttctcg caaatccagt caccacccat gttccaaagcg cggaaacaaca 1560
 taatcaagac gttaaatttc tccgatataat tccatggagg aaaaacggcag aacgcgttgcg 1620
 catctttaaaa ctcatgttgtt cggatcttgcgtt cggatcttgcgtt aatacgatctt tccatgggtgg 1680
 ccattttggaa gagaacatca aatcgacagt gaaacccatca gtaagccaaag tccatgttgtt 1740
 ggtttccacc atgggggtca acggggaggtt cccatggcg agatcttgcg agaaagatct 1800
 cctccgtgtt gttgtatgtt aatacgatctt cggatcttgcgtt gacgacgtttt gcaacggcgc 1860
 atatccattttaatgcaaaagc tccgacatgtt tccatgggtggccatccatcaaaatgg 1920
 aacggagaag aacactaaca cccatgttgtt cccatgggtggccatccatcaaaatgg 1980

gaaagtccgtt acccgaaag aagttgaagg tggtagaatac gcttatgaga atgatacatt 2040
gtcgattcca aacaggatta aagcttgcag atcgtaaccg ttgtataggt ttgttaaggaa 2100
ggagctcggc agagggttt tgaccggaga aaaggtgacg tcgcccggag aggagttcga 2160
cagggtgttc acggcgatgt gaaaaggatca aattattgtat ccgttggatgg agtgtttgg 2220
agggtggaaat gggaaacctc ttccaaatatg ttaggaaagt gagtgtgaaa ccgtttgaat 2280
tgtatgttataatctgtt tttttttttt ttttttaaat tttatttgcata tttaaatataat 2340
catcaaagac ttccacttcc aagtgtgtg tttgtgttgcataatcatat atattaactt 2400
attattttttgcataaaaaaaaaaaaaaaaaaaaaaa aa 2440

<210> 4
<211> 2380
<212> DNA
<213> Lactuca sativa

<220>
<223> lettuce phenylalanine ammonia-lyase (PAL) 2
(LsPAL2) cDNA

<220>
<221> CDS
<222> (77) . . . (2218)
<223> PAL2

<400> 4
gcagcaacccg ccacttcacc accttcaatc cctcattctc tctctctaaa aaaaccagac 60
tctgttaattt ctgataatgg gcagcacaga aatggagggtt gatagccatc aaaacgggtga 120
gagagcggag ttttgtgtga aaggggatcc tttgaactgg gggatggcgg cggagtcatt 180
aaagggtagt catttagacg aggtgaagcg gatgggtggcg gagtttagga agccgggtgg 240
gagattgggtt ggagagacgt tgactgtgtc gcaggtggcg gcgatcggcgg ccagtgataa 300
cgctgggggtg aagggtggaa tgcggagac ggcgaggggcg ggggtgaagg cggagtagtga 360
ttgggtgtatg gagagtatga ataaaggaaat ggatagatcat ggtgtcaacta ccgggttccgg 420
agctacatctt caccggagaa cggaaagg tgggtgttccat cagaaggagc tcatttagatt 480
tttggaaatggc ggaatattcg gtaatggcac agaatcaacc cacacacttc cacattcagg 540
cacaagagca gccatgcctg tcaaaatcaa cacccttcatt caaggttaact ccggcattccg 600
atccgagatc ttggaggcga tcaccaagtt cctcaaccac aacgtcaacc ctttctcc 660
tctccgtggg acaattaccg cctccggcga tctctgtccca ttatccata tcggccggct 720
tctcaccggc cgtggcaact cccaaaggccgt tggacccacc ggagaagttt taaaatggcga 780
aaaggccctt gggaaaggccg gagttgaagg tggtttccat gagtttacgg cggaaagg 840
gctagcactt gtcaacggca ccggccgtggg atccggatg cgcgtcgatgg tgctatgttga 900
tgctaatgtt cttgcattgt tgctggaaatgtt gttatccggc atcttcgtcg aagttatgtca 960
aggttaaggccg gagtttactg atcaacttaac acacaaattt aagcatcacc ccggtcaat 1020
cgaggccggc ggtatcatgg agtataattt ggacggaaac gattaaatcgca aggcggccgca 1080
aaagggtccac gaaatggacc ctttacagaa accaaaacaa gatgttatg ctctccgtac 1140
atctcccaaa tggctggac ctcaaatcgaa agtataccgaa tcataccaa aaatgtatcg 1200
gagagaaaatc aactccgtca acgacaaaccc attgatcgac gtttccagaa acaaaggccctt 1260
acacgggtggc aacttccaaat gaaacccaaat cggagtttccat atggataaca cacgtttggc 1320
gatcgccggcc atcgaaatgc taatgttccgc tcagtttctt gagtttgcac acgatttttt 1380
caacaaacggg ttggccatcca atctctccgg cggccggaaat ccaagtttgg attacgggtt 1440
caaagggtgca gaaatcgccaa tggcttccat ctgtctgtttt cttccgttcc tcggccaaatcc 1500
agtccacaaat cccgttcaaa gggccgaaca acacaaaccaa gatgttaattt cttgggattt 1560
gatttcagca agaaaaacag cagaatcaatgtt cggatcttta aaactcatgtt caaccacata 1620
tttagtagctt ctatgtcaat ccatcgatctt gaggattttgc gaaagaaacc tggaaatccat 1680
agtgtaaagaaatc acgttgagcc tggatggcgaat gaaatgttttgc accacccgggg tcaatggcga 1740
gttccacccctt ttcgttttttgc gggagaaatgc ctttgcgttttgc gttgttgcata 1800
ttttgcataatc atcgacgcgc cttgcggcgc caccatccaa ttgtgttgcata 1860
gtttatgttc gaccacgcata taaacaaacgc aaatgtacggc ggaacttccca ttttccaaa 1920
gatgtgttgc gggagaaatgc aactgtaaatgc ctttttgcata 1980
aaggccataatc gggatgttgcata ttttgcataatgc atcaaggatgttgcata 2040
cccatgttgcac aggtttgttgc gggatgttgcata ttttgcataatgc gggaggatgttgcata 2100
gacgttcacccctt gggatgttgcata ttttgcataatgc gacatattat 2160

cgatccattg ttggagtgtg ttcaagggtg gaatgggttt cctcttccga tttcatagtt 2220
attttgcataaataacttt ttatgaggtt tgagggtttt gtaagtcgca actctcatgc 2280
caaatgtgtatgtactatt gtatgtttgt aattgtacca cgttaagtgt 2340
acctttgtt tcataaaaaaa aaaaaaaaaa aaaaaaaaaa 2380

<210> 5
<211> 666
<212> PRT
<213> Helianthus annuus

<220>
<223> sunflower phenylalanine ammonia-lyase (PAL)

<400> 5
Met Glu Asn Gly Thr His Val Asn Gly Ser Ala Asn Gly Phe Cys Ile
1 5 10 15
Lys Asp Pro Leu Asn Trp Gly Val Ala Ala Glu Ala Leu Thr Gly Ser
20 25 30
His Leu Asp Glu Val Lys Lys Met Val Gly Glu Phe Arg Lys Pro Val
35 40 45
Val Lys Leu Gly Gly Glu Thr Leu Thr Val Ser Gln Val Ala Gly Ile
50 55 60
Ser Ala Ala Gly Asp Gly Asn Met Val Lys Val Glu Leu Ser Glu Ala
65 70 75 80
Ala Arg Ala Gly Val Lys Ala Ser Ser Asp Trp Val Met Glu Ser Met
85 90 95
Asn Lys Gly Thr Asp Ser Tyr Gly Val Thr Thr Gly Phe Gly Ala Thr
100 105 110
Ser His Arg Arg Thr Lys Asn Gly Gly Ala Leu Gln Lys Glu Leu Ile
115 120 125
Arg Phe Leu Asn Ala Gly Ile Phe Gly Asn Gly Thr Glu Ser Ser His
130 135 140
Thr Leu Pro His Ser Ala Thr Arg Ala Ala Met Ile Val Arg Ile Asn
145 150 155 160
Thr Leu Leu Gln Gly Tyr Ser Gly Ile Arg Phe Glu Ile Leu Glu Ala
165 170 175
Ile Thr Lys Phe Leu Asn Asn Asn Ile Thr Pro Cys Leu Pro Leu Arg
180 185 190
Gly Thr Ile Thr Ala Ser Gly Asp Leu Val Pro Leu Ser Tyr Ile Ala
195 200 205
Gly Leu Leu Thr Gly Arg Pro Asn Ser Lys Ala Val Gly Pro Ala Gly
210 215 220
Glu Val Leu Asn Ala Glu Ser Ala Phe Ala Gln Ala Gly Val Glu Gly
225 230 235 240

Gly Phe Phe Glu Leu Gln Pro Lys Glu Gly Leu Ala Leu Val Asn Gly
245 250 255

Thr Ala Val Gly Ser Gly Met Ala Ser Met Val Leu Phe Glu Ala Asn
260 265 270

Val Leu Ala Leu Leu Ser Glu Val Leu Ser Ala Ile Phe Ala Glu Val
275 280 285

Met Gln Gly Lys Pro Glu Phe Thr Asp His Leu Thr His Lys Leu Lys
290 295 300

His His Pro Gly Gln Ile Glu Ala Ala Ile Met Glu Tyr Ile Leu
305 310 315 320

Asp Gly Ser Asp Tyr Val Lys Ala Ala Gln Lys Val His Glu Met Asp
325 330 335

Pro Leu Gln Lys Pro Lys Gln Asp Arg Tyr Ala Leu Arg Thr Ser Pro
340 345 350

Gln Trp Leu Gly Pro Gln Ile Glu Val Ile Arg Ser Ala Thr Lys Met
355 360 365

Ile Glu Arg Glu Ile Asn Ser Val Asn Asp Asn Pro Leu Ile Asp Val
370 375 380

Ser Arg Asn Lys Ala Leu His Gly Gly Asn Phe Gln Gly Thr Pro Ile
385 390 395 400

Gly Val Ser Met Asp Asn Thr Arg Leu Ala Ile Ala Ala Ile Gly Lys
405 410 415

Val Thr Ile Ala Gln Phe Ser Glu Leu Val Asn Asp Phe Tyr Asn Asn
420 425 430

Gly Leu Pro Ser His Leu Ser Gly Gly Arg Asn Pro Ser Leu Asp Ser
435 440 445

Gly Phe Lys Gly Gly Glu Ile Ala Met Ala Ser Tyr Cys Ser Glu Leu
450 455 460

Gln Phe Leu Ala Asn Pro Val Thr Asn His Val Gln Ser Ala Glu Gln
465 470 475 480

His Asn Gln Asp Val Asn Ser Leu Gly Leu Ile Ser Ala Arg Lys Thr
485 490 495

Ala Glu Ala Val Asp Ile Leu Lys Leu Met Ser Ser Thr Tyr Leu Val
500 505 510

Ala Leu Cys Gln Ser Ile Asp Leu Arg His Leu Glu Glu Asn Met Lys
515 520 525

Ser Thr Val Lys Asn Thr Val Ser Gln Val Ala Lys Lys Val Leu Thr
530 535 540

Met Gly Val Asn Gly Glu Leu His Pro Ser Arg Phe Cys Glu Lys Asp
545 550 555 560

Leu Leu Arg Val Val Asp Arg Glu Tyr Val Phe Ala Tyr Ala Asp Asp
565 570 575

Pro Cys Leu Thr Thr Tyr Pro Leu Met Gln Lys Leu Arg Gln Val Leu
580 585 590

Val Asp His Ala Leu Asn Asn Gly Glu Thr Glu Lys Asn Ala Asn Thr
595 600 605

Ser Ile Phe Gln Lys Ile Ala Thr Phe Glu Asp Glu Leu Lys Ala Ile
610 615 620

Leu Pro Lys Glu Val Glu Ser Val Arg Val Ala Phe Glu Asn Gly Thr
625 630 635 640

Met Ser Ile Pro Asn Arg Ile Lys Ala Cys Arg Ser Tyr Pro Leu Tyr
645 650 655

Arg Phe Val Arg Glu Glu Leu Gly Gly Ala
660 665

<210> 6

<211> 17

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence:PCR 5'
degenerate primer

<220>

<221> modified_base

<222> (1)..(17)

<223> n = g, a, c or t

<400> 6

gayccnytna aytgggg

17

<210> 7

<211> 20

<212> DNA

<213> Artificial Sequence

<220>

<223> Description of Artificial Sequence:PCR 3'
degenerate primer

<220>

<221> modified_base

<222> (1)..(20)

<223> n = g, a, c or t

<400> 7

ccytgraart tnccnccrtg

20

<210> 8
<211> 6
<212> PPT
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:PAL conserved
region peptide fragment from sunflower (*Helianthus*
annuus), *Arabidopsis thaliana*, parsley
(*Petroselinum crispum*), carrot (*Daucus carota*),
rice (*Oryza sativa*), or wheat (*Triticum aestivum*)

<400> 8
Asp Pro Leu Asn Trp Gly
1 5

<210> 9
<211> 7
<212> PRT
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:PAL conserved
region peptide fragment from sunflower (*Helianthus*
annuus), *Arabidopsis thaliana*, parsley
(*Petroselinum crispum*), carrot (*Daucus carota*),
tobacco (*Nicotiana tabacum*), rice (*Oryza sativa*),
or wheat (*Triticum aestivum*)

<400> 9
H.s Gly Gly Asn Phe Gln Gly
1 5

<210> 10
<211> 6
<212> PRT
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:PAL conserved
region peptide fragment from tobacco (*Nicotiana*
tabacum)

<400> 10
Asp Pro Leu Asn Trp Glu
1 5

<210> 11
<211> 5
<212> PRT
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:PAL conserved
peptide fragment

<400> 11
Asp Pro Leu Asn Trp
1 5

<210> 12
<211> 23
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:forward primer

<400> 12
cggaattcat ggagaacggt aat

23

<210> 13
<211> 23
<212> DNA
<213> Artificial Sequence

<220>
<223> Description of Artificial Sequence:reverse primer

<400> 13
cgtctagact aacatattgg aag

23